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Earth Tones... The Book

Federal Science for Sustainable Development

Canada

EARTH TONES...ON THE DISCOVERY CHANNEL

Television is a major source of information today. Keeping in step, federal science is front and centre on the Discovery Channel under a unique partnership among resource-based government departments.

Aired on Discovery's flagship science news magazine program @discovery.ca, *Earth Tones* features government scientists at work—reducing greenhouse gases, conserving our genetic resources, saving energy in our homes and on our highways, protecting us from dangerous microorganisms in our food and water, and monitoring the health of our oceans. Together, this programming presents a picture of the many ways government scientists are tackling environmental issues that affect the quality of life for Canadians.

This companion book highlights other challenges addressed by federal scientists like those seen on @discovery.ca. Check your local listings for times in your area.

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Earth Tones... The Book

Federal Science for Sustainable Development

Prepared by
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Agriculture and Agri-Food Canada

For
Agriculture and Agri-Food Canada
Environment Canada
Fisheries and Oceans Canada
Health Canada
Natural Resources Canada

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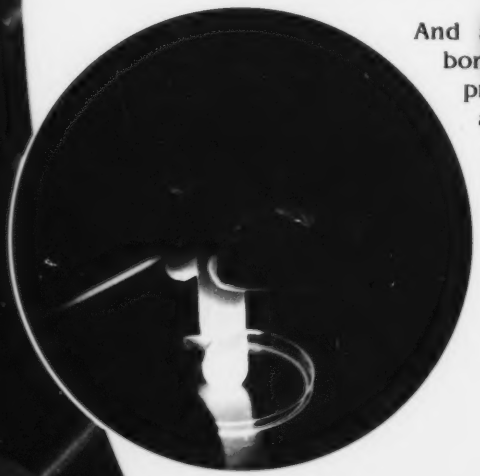
Our environment defines us. It shapes our economy, affects our health, influences our activities—it sustains us. And we, in turn, must sustain our environment by addressing the needs of our present world without sacrificing the ability of future generations to meet theirs.

From choosing recycled paper, using energy-efficient appliances and restoring damaged ecosystems, to replanting forests and reducing greenhouse gas emissions, Canadians in all sectors of society have a responsibility for sustainable development. Since development is necessary to satisfy human needs and improve the quality of life, we must ensure that the ecological balance is conserved.

Five heads are better than one

In 1995, the five federal government departments dealing with natural resources—Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada—banded together to encourage collaboration and coordination in the use of science and technology for sustainable development. This group is known as 5NR.

The 5NR gives a collective focus to the member departments' mandates in an effort to protect the long-term health and diversity of all species, promote energy efficiency and clean technologies, and wisely manage and conserve renewable resources. The departments are working toward this goal by collaborating on research, sharing success stories and disseminating information.



And since the environment doesn't recognize borders, 5NR collaborates with private industry, provincial and municipal governments, foreign agencies and grassroots groups to collect data, test solutions and share knowledge and innovations.

Show and tell

Wonder what the hot topics in sustainable development are? Interested in the latest R&D? Want to know who's who in 5NR? We've got the answers!

5NR makes its activities and findings about Canadians pitching in, biodiversity, climate change, air and water toxins, and health and Canadians available in multiple formats.

- Tune in to the Discovery Channel for *Earth Tones* (check your local listing).
- Log on to the 5NR web site at www.nrcan.gc.ca/rn4nr/
- Download a copy of this brochure.

Low sea survival threatens salmon

Department of Fisheries and Oceans

Atlantic salmon leaving Nova Scotia rivers for the Bay of Fundy and the Gulf of St. Lawrence to winter at sea for the first time are failing to return to their natal rivers. Something is killing the smolts at sea. Although the usual suspects—fisheries, predators, food shortages—have been examined, no clear culprit in the stocks' decline has been identified.

Scientists at the Department of Fisheries and Oceans examined levels of freshwater production, legal and illegal fisheries, predation, forage availability, marine environmental conditions, disease, parasites and factors such as delayed maturation. No single factor was identified to explain the low sea survival.

However, there are indications that the ecosystem of the Northwest Atlantic has changed since the late 1980s, and may be a factor in the low return rates of salmon. For instance, below-normal water temperatures, large-scale changes in the distribution and abundance of Atlantic herring, Arctic cod, Greenland halibut and snow crab, and changing diets of seabirds such as Funk Island gannets, have an impact on the marine ecosystem.

"At the return of two to four per cent of wild smolts, most salmon rivers south of Sydney, Nova Scotia can't produce enough smolts from each spawning to remain viable," says Peter Amiro, a researcher with the Department of Fisheries and Oceans. "This is aggravated by the effects of acid rain in much of this area."

Historically, Atlantic salmon populations have displayed a high resilience (except where habitat has been eliminated or severely degraded) even while fluctuations in their number have been severe. But the abundance of Atlantic salmon has generally declined since the 1970s, and 14 stocks in Nova Scotia's more than 60 salmon-bearing rivers are now extinct. Research programs on salmon at sea are needed to increase our knowledge of the life history of salmon in the Atlantic Ocean.

For further information, contact Peter Amiro at (902) 426-8104.

Taxonomy on the Web

Agriculture and Agri-Food Canada

In September 1999, the Integrated Taxonomic Information System (ITIS) was launched on the Internet in Canada. Now, searching for basic scientific information on taxonomy—the science of classification of life-forms—is a whole lot easier.

The ITIS project, initiated by the U.S. Geological Survey (USGS) and other American partners, is an international attempt to build the first comprehensive, standardized reference for the scientific names of the flora and fauna of North America and surrounding oceans.

Agriculture and Agri-Food Canada's Eastern Cereal and Oilseed Research Centre (ECORC), in partnership with USGS, expanded the ITIS database to Canada, and added some innovations of its own. The Canadian Web site (http://res.agr.ca/itis/) features CanExplore, a search engine that provides access to a wealth of taxonomic and biodiversity information maintained by the federal government. It's also part of an Internet Search Portal that allows users to expand their queries to the rest of the Internet for information relevant to agriculture, biodiversity, molecular genetics and international trade.

"Our involvement in ITIS is a logical extension of the biosystematics research we have been doing in Ottawa over the past 115 years," says Dr. Jean-Marc Deschênes, director of ECORC. "We are pleased to collaborate with our U.S. partner agencies in developing a product

that will support the efforts of the entire biological sciences community."

Now that the Canadian site is up and running, ECORC taxonomists have volunteered to take stewardship of major taxonomic groups in the system. Efforts are under way to certify the quality of existing records and accelerate the rate at which the database is expanded.

For more information, contact ECORC's Dr. Guy Baillargeon, at (613) 759-1565.

Urban jungles: reaping the benefits

Environment Canada

Vine-covered facades and lush rooftop gardens offer more than a green oasis in the concrete jungle. As shown by an Environment Canada report for the Canada Mortgage and Housing Corporation (CMHC), vertical and roof-top gardens can help urban areas adapt to climate changes such as frequent heat waves and extreme rainfall, and improve air and water quality.

According to *Greenbacks from Green Roofs: Forging a New Industry in Canada*, vertical and rooftop gardening

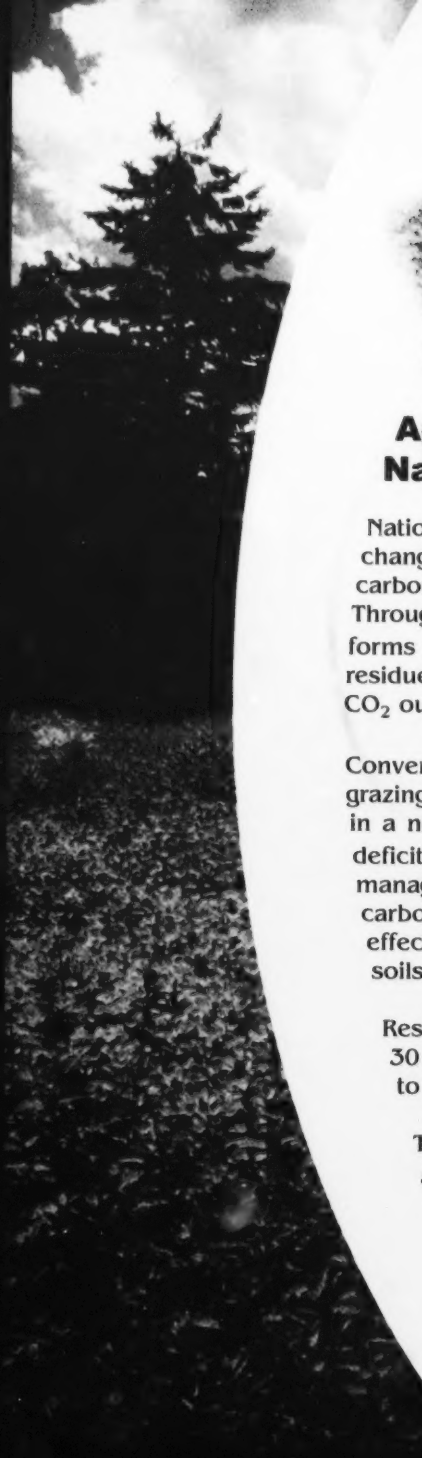
- reduces energy usage (and thereby greenhouse gas emissions) by protecting buildings from wind in winter and providing direct shading and evaporative cooling in summer
- reduces the amount of re-radiated heat in urban centres through evapotranspiration, resulting in a reduction in the "urban heat island," which has been linked to increased energy consumption and health problems
- reduces the amount of precipitation runoff and removes up to 95 per cent of heavy metal pollutants in runoff
- improves air quality by filtering out gaseous pollutants and particles, and reducing dispersion of pollutants over wider areas

- protects building membranes from ultraviolet radiation and weather-related damage
- serves as habitat for wildlife.

With the review complete, Environment Canada scientists and partners from the National Research Council and the roofing industry are embarking on a two- to five-year monitoring project. They will compare differences in water quality, energy usage and other environmental factors between two identical roofs in Ottawa, Ontario: one with vegetation, the other without.

In addition, Environment Canada scientists will be using computer models to simulate the performance of rooftop gardens over longer time periods in different cities. Through the report and research (supported by a grant from the Climate Change Action Fund), they hope to raise awareness about the potential rooftop and vertical gardens hold in helping Canadians meet the climate change challenges of the new millennium.

For a copy of the report, contact the CMHC Reference Desk at (613) 748-2367 or Brad Bass at (416) 978-6285. For more information on the research projects, Mr. Bass can also be reached at brad.bass@ec.gc.ca.



Soil sinks: CO_2 reservoirs

Agriculture and Agri-Food Canada
Natural Resources Canada

Nations around the world can use a powerful tool to combat climate change, and it's right under our feet. Soils can absorb atmospheric carbon—which is linked to global warming—with the help of plants. Through photosynthesis, plants convert carbon dioxide (CO_2) into organic forms of carbon that they deposit in the soil through their roots and residue. With sound land management, these soil carbon sinks can keep CO_2 out of the atmosphere.

Conversely, the conversion of grasslands and forests to agricultural and grazing land, unsustainable land practices and the tilling of soil can result in a net release of CO_2 into the atmosphere, and can create a carbon deficit in soil. Models can estimate the carbon change related to farm management practices with a fair degree of accuracy using data on soil carbon, landscape and climate. A scientifically credible and cost-effective way of measuring, monitoring and verifying carbon changes in soils is in development.

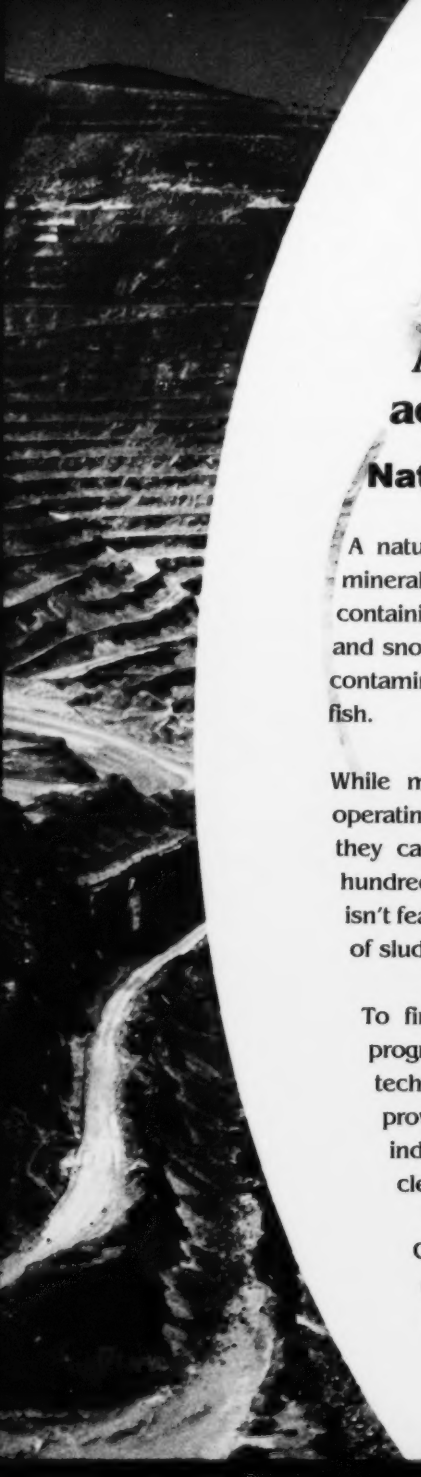
Researchers predict that world soils have the potential to absorb 20 to 30 gigatonnes of carbon during the next 50 to 100 years. That's equal to five times the world's fossil fuel emissions for 1990.

The role of northern forests in sequestering and releasing CO_2 is also being studied by scientists at the Canadian Forest Service.

They're also developing strategies to measure forest capacity to store atmospheric CO_2. In addition, researchers are constructing predictive models to help forest managers understand and cope with the impact of changing climatic conditions on forest ecosystems, fire regimes and pest infestations in Canada. Understanding the causes and potential effects of climate change and variability is critical to developing actions to mitigate and adapt to future climate changes.

For more information on farming practices to increase the amount of soil carbon, contact the Environment Bureau of Agriculture and Agri-Food Canada at (613) 759-7307.

For more information on the role of forest management and CO_2 sequestering, contact Bob Stewart of the Canadian Forest Service at (613) 947-9014.



Toxins in air and water

A drain on the environment: acid mine drainage and hog manure

Natural Resources Canada

A natural, chemical reaction with oxygen and water is changing sulfide minerals in copper, zinc, nickel, gold and uranium mines into acidic seepage containing concentrations of metals and dissolved salts. If left untreated, rain and snow melt carry the solution into surrounding bodies of water, possibly contaminating groundwater and damaging the health of plants, wildlife and fish.

While mining companies collect and treat effluents and seepage from operating mines by using acid-neutralizing materials, such as calcite or lime, they can't continue to neutralize the acidic run-off that can persist for hundreds of years after mine closure. Operating treatment plants indefinitely isn't feasible, in part because they would generate an unmanageable volume of sludge.

To find a solution, the Mine Environmental Neutral Drainage (MEND) program was established in 1989 to develop scientifically based technologies to combat acidic drainage. Over the next 10 years, provincial and federal governments, together with the Canadian mining industry, spent over $17 million to reduce the costs associated with site clean-up by $400 million.

Collaborative research has resulted in over 200 projects. Since it is difficult to stop seepage once sulfide mineral begins to react, prevention is the best strategy.

To that end:

- lab and field prediction tests for waste rock and tailings have been investigated and further developed
- the use of water covers and underwater disposal is being confirmed in Canada as the preferred way to prevent sulfide-containing wastes from oxidizing
- dry cover research shows that a range of materials (including low-cost waste from other industries, such as compost and paper mill sludge) has excellent potential as oxygen-reducing surface barriers. Research also shows that nonacid-generating tailings can be used as the fine, moist layer in composite surface barriers instead of the traditional glacial till and clays.

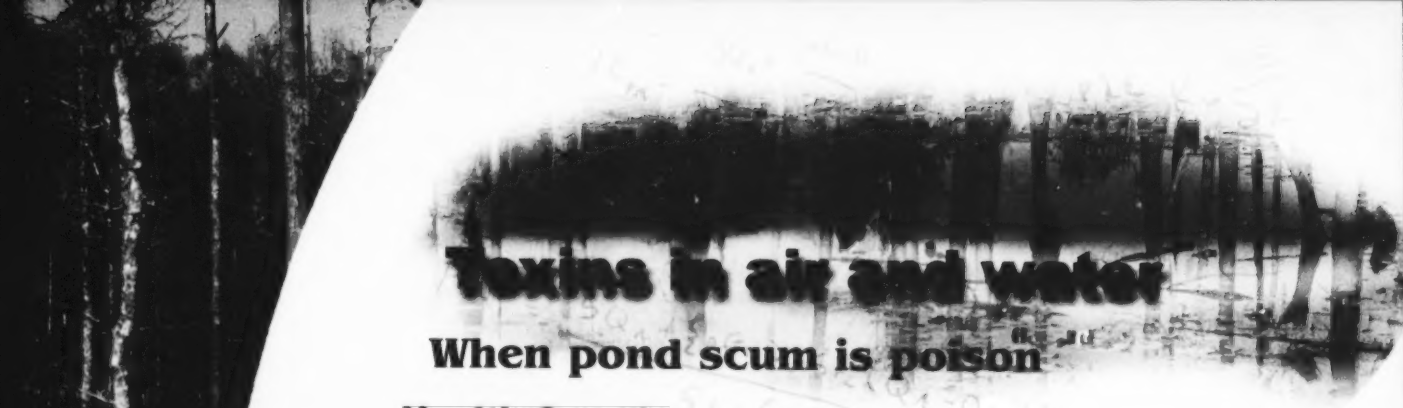
With the conclusion of the MEND program in 1997, the partners agreed that additional cooperative work was needed. The three-year MEND 2000 program was started in January 1998 to facilitate the transfer of acidic drainage prevention technology.

Meanwhile, researchers are coming to grips with contaminants from an organic source. Hog manure can be carried by rain and runoff into water deep beneath the soil, seeping into wells, rivers and lakes. Scientists are working on a project dealing with issues and constraints linked to managing hog manure, and the need to provide guidance on the best practices to limit damage to soils and groundwater.

Building on expertise and technology originally developed for coal studies, the Geological Survey of Canada is mapping the shallow sediments and developing groundwater models at test sites in the Prairies. The goal is to be able to apply the findings and the Geographical Information System methodology to other sites.

For more information on acid mine drainage, visit http://mend2000.nrcan.gc.ca, or contact Gilles Tremblay at (613) 992-0968.

For further information on hog manure and groundwater, contact Dr. Grant Mossop at (403) 292-7049.



Toxins in air and water

When pond scum is poison

Health Canada

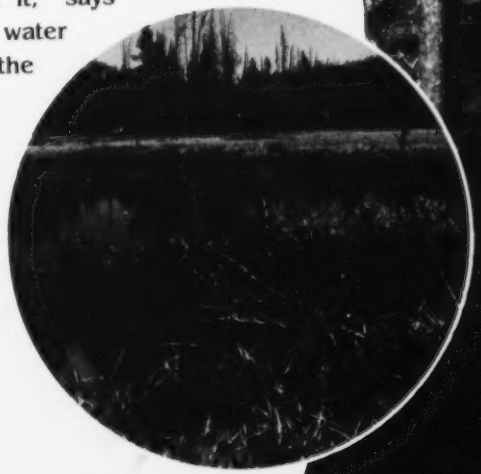
Most of us can identify blue-green algae, or cyanobacteria (which can vary in colour from olive-green to red), as pond scum when a mass of it has risen to the surface of warm, shallow water that is slow-moving or still. This scum is called a bloom. What we can't identify by looking at the bloom is whether the cyanobacteria is storing naturally produced toxins in its cells.

Not all blooms are toxic, but we have to assume they are until tested, says Michèle Giddings, Senior Evaluator, Drinking Water Section, Health Canada. So we need tests that can be done routinely on limited resources—tests that are easy to use and that don't take a lot of time.

Giddings is involved in two projects to develop such tests. She works with Health Canada researchers on the Environmental Health research project which modified a costly and time-consuming lab test. The result is a readily accessible and affordable analytic methodology to determine quantitatively the total amount of cyanobacteria hepatotoxins (toxins that affect the liver) in a water supply inhabited by these blooms. The methodology is ready for inter-laboratory testing in the summer of 2000 as part of an interprovincial survey.

The second project, a toxin presence–absence test kit based on protein phosphates inhibition, was developed in collaboration with Dr. Charles Holmes of the Department of Biochemistry at the University of Alberta. A positive result would indicate the presence of toxins, and further laboratory testing would determine the amount of toxins. The prototype test kit, which is also ready for testing next summer, is portable and easy to use—features that increase its market potential, especially in the Prairies where blooms are common in dugout reservoirs.

"Eventually, we hope anyone will be able to use it," says Giddings. "It would allow for routine monitoring of water sources with a history of blooms. The test tells us if the water is safe from these toxins."



For more information, visit www.hc-sc.gc.ca/waterquality or contact Michèle Giddings at (613) 952-2594 or water_eau@hc-sc.gc.ca.

Amphipod barometers for PCBs

Department of Fisheries and Oceans

In the cold, deep water of the Arctic Ocean swims a sentinel of the seas. Because of its scavenged diet of invertebrate, fish and marine mammal carcasses, its high proportion of fat (25 per cent of its body weight), and biomagnification between successive predator–prey links, *Eurythenes gryllus* has become a barometer for organic contaminants in the Arctic Ocean marine food web.

The bright red amphipod (a large shrimp-like invertebrate) was studied as part of the Northern Contaminants Program, the largest study in Canadian history to investigate the sources, transport pathways and site of accumulation of contaminants in the Arctic ecosystem. Dr. Barry Hargrave, a marine ecologist with the Department of Fisheries and Oceans, analysed the lipid-soluble chemicals—such as PCBs and organochlorine pesticides—that had accumulated in the amphipods' fatty tissue.

Amphipods were collected using baited traps, much like those used for crab and lobster, on the ocean floor. To position the traps, the Bedford Institute of Oceanography in Dartmouth, N.S., custom-built a portable electric winch for use during the U.S. Scientific Ice Expeditions (SCICEX) program. SCICEX submarines collected

samples in 1996 and 1998, which, when analysed, showed that levels of the pesticide toxaphene in amphipods had dropped from samples collected in 1983.

By using amphipods as an indicator, scientists can monitor spatial and temporal trends in organic contaminant distribution in the marine food web. The information can help to predict changes in levels of pollutants in fish harvested as food from arctic waters.

For more information, contact Dr. Barry Hargrave at the Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, N.S., at (902) 426-3188 or hargraveb@mar.dfo-mpo.gc.ca.

Health and Canadians

Raw milk cheeses

Health Canada

Most Canadians associate food poisoning with the improper handling or undercooking of meat and poultry. But the same microbial contaminants—*E. coli, Salmonella, Campylobacter* and *Listeria*—can taint other products of animal origin. One such product, raw milk cheese, will be the subject of a major government–industry collaborative study to determine what risk it presents to Canadians.

Because there is no microbial "kill step" in the cheese-making process, soft and semi-soft cheeses retain any contaminants present in the unpasteurized milk from which they are made. This means raw milk cheeses such as brie and camembert present a higher risk of contamination than pasteurized milk cheese, such as cheddar, or hard cheeses like parmigiano.

Beginning in April 2000, the bacterial quality of Canadian raw milk cheese will be studied by Health Canada and the Canadian Food Inspection Agency, with the voluntary participation of cheese manufacturers and the cooperation of government agencies in provinces that manufacture it (New Brunswick, Nova Scotia, Quebec, Manitoba, Alberta and British Columbia).

The Dairy Farmers of Canada will facilitate this 12-month phase of the study. The second phase of the study will survey imported raw milk cheese.

Information on food safety can be found on Health Canada's Web site at www.hc-sc.gc.ca. For information on the raw milk cheese study, contact Jeff Farber, Chief of the Microbiology Research Division, Health Canada, at (613) 957-0895.

Canadians Pitching In

Wildlife watchers

Environment Canada

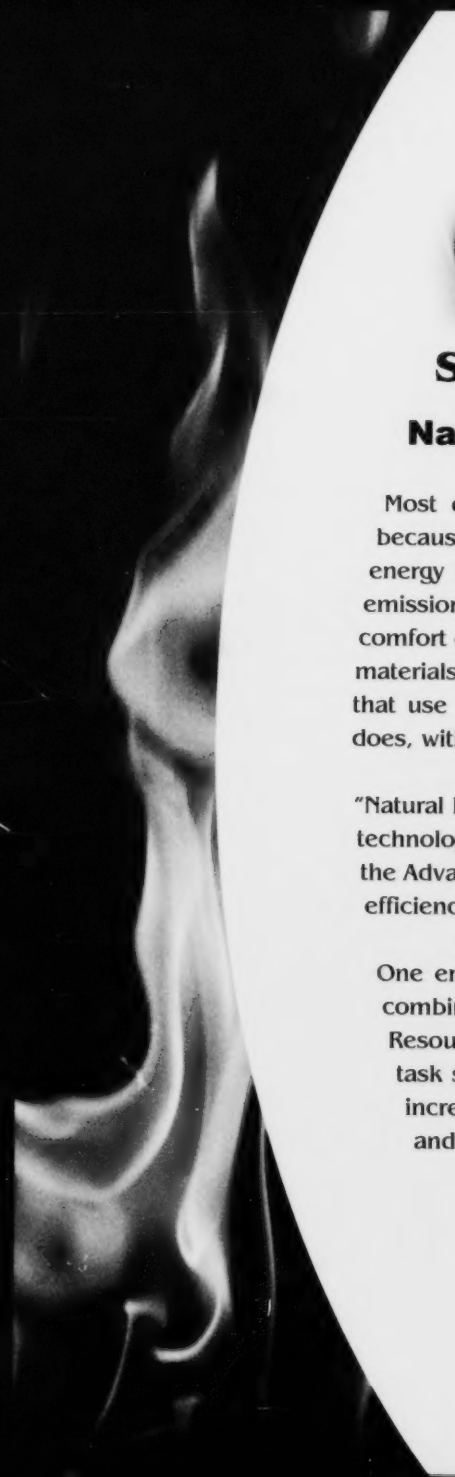
Every year near Christmas, while Santa is making his list, birders in 80 cities and towns across Ontario spend one day making a list of their own. These volunteers in the hundred-year-old Christmas Bird Count diligently watch for and count birds in their neighbourhoods to gather information about bird populations.

The Christmas Bird Count is just one of the Wildlife Watchers projects the Canadian Wildlife Service draws data from. The projects, which involve thousands of volunteers across Ontario, are designed to be as effective as possible while still being interesting and enjoyable. All are scientifically rigorous, meaning that the valuable data collected can be used to measure population status and trends to help define appropriate conservation actions and assess the success of conservation initiatives.

"These projects are entirely dependent on volunteers," says Mike Cadman, Canadian Wildlife Service, Ontario Region. "Canada is such a huge expanse of land, there is no way professionals can monitor everything, so we rely on birders, with their tremendous field skills, to fill in the gaps."

Wildlife Watchers grew out of the Canadian Landbird Monitoring Strategy in 1994, and has recently added marsh bird and amphibian projects. "The amphibian projects probably require the least experience because there are only about 11 species to identify, while projects like the Forest Bird Monitoring Project or Breeding Bird Survey require a lot of expertise," says Cadman. "But all the projects are intended to have a minimal time commitment."

To find a project that matches your interests and experience, or to find out more about about wildlife conservation, visit Environment Canada's Green Lane at www.ec.gc.ca.



Canadians pitching in

Saving energy at home

Natural Resources Canada

Most of us are concerned with the energy efficiency of our homes because we want the hydro and oil bills to be as low as possible. But energy efficiency has other benefits, such as reducing greenhouse gas emissions (a leading cause of global warming), improving the health and comfort of occupants, and reducing the demand for energy. Innovations in materials, technology and techniques mean that today we can build houses that use as little as one-quarter of the energy that a conventional home does, with corresponding reductions in CO_2 emissions.

"Natural Resources Canada works closely with industry to develop and test technology that developers and homeowners can use," says Skip Hayden of the Advanced Combustion Technology Lab. "Our goal is to improve energy efficiency affordably."

One energy-saving innovation expected to hit the market in 2002 is a combined space/water/ventilation system developed by the Natural Resources Advanced Integrated Mechanical Systems Program. The multi-task system, currently in the prototype stage, would reduce costs and increase efficiency by replacing traditional furnaces, hot water heaters and air exchangers with one integrated system.

Given that Natural Resources laboratories are leaders in the development of energy-saving products for Canadians, it's not surprising that their innovations include

- windows that are more energy efficient than walls (because they capture more heat from the sun than they allow to escape)
- smart house control systems that optimize energy use from hour to hour and from room to room
- super-slow combustion woodstoves recognized as the best in the world for emitting only a fraction of the CO_2 of conventional fireplaces
- the world's most efficient solar heating system.

With all the energy-efficiency improvements available to Canadians, we can heat our homes without heating the earth. To find out how you can improve your home's energy efficiency, call 1-800-387-2000 to order a free booklet. For information on integrated systems, contact Skip Hayden, Advanced Combustion Technology, at (613) 996-3186.

Natural Resources Canada is working with Canadians on a number of other fronts, as well. Educational outreach projects such as Geoscape Posters and the *Canadian Communities Atlas* aim to keep people interactively connected with their geographical environment. You can learn more about these projects on the following web sites:
www.nrcan.gc.ca/gsc/education_e.html
cgdi.gc.ca/ccatlas

Conclusion

To be successful in fostering sustainable development, government departments are strengthening and sharing their scientific and analytical expertise. We are working with industry, other countries and each other to develop innovative tools and approaches to sustaining our environment.

But the collaboration doesn't stop there. The responsibility for sustainable development is shared by everyone—and we all have a role to play. Whether we join a bird counting program, plant an urban garden, car-pool or purchase energy-efficient building materials, our contribution makes a difference to the health of our environment.

Be sure to use the contact information provided to find out more about the research and activities in this brochure. Check out *Earth Tones* on the Discovery Channel and the 5NR Web site for more sustainable development research and project news.